(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 034 067
B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of the patent specification: 24.10.90

(51) Int. Cl.⁵: A61G 7/00

(21) Application number: 89201652.8

(22) Date of filing: 21.06.89

(54) **A hydraulic actuating unit, in particular for raising a load, such as a hospital bed.**

(30) Priority: 28.06.88 NL 8801644

(43) Date of publication of application: 03.01.90 Bulletin 90/1

(45) Publication of the grant of the patent: 24.10.90 Bulletin 90/43

(84) Designated Contracting States: CH DE ES FR GB IT LI NL SE

(56) References cited: DE-A- 3 021 559

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Description

The invention relates to a hydraulic actuating unit, in particular for raising a load, such as a hospital bed, comprising a reservoir for hydraulic fluid and a hydraulic piston cylinder device, the cylinder of the latter having its ends connected to the reservoir through a supply conduit containing a hydraulic plunger pump with section and pressure valve means and through a return conduit containing an orifice and a normally closed relief valve respectively, a branch conduit leading to a hydraulic liquid accumulator being branched off from said supply conduit at a location between the cylinder and the pressure valve means, a check valve being provided in said supply conduit at a location between the branch conduit and said cylinder, while a pressure dependent orifice is provided between said check valve and said branch conduit to said accumulator.

Such an actuating unit is known with vertically adjustable hospital beds and is rather inexpensive. For raising the bed, e.g. up to the level of an operating table, the pump (usually of the single plunger type) is manually or foot-operated, so that hydraulic fluid is intermittently supplied to the hydraulic cylinder. The accumulator operates as a hydraulic shock absorber, and minimizes the shocks at the beginning and the end of each pressure stroke of the pump.

It will be understood, that the supply conduit 11 extending from the branch location towards the cylinder, and the branch conduit are dimensioned such one relative to the other that when actuating the unit, the accumulator will be filled up "with priority" through the branch conduit. Lowering of the bed will take place by causing the relief valve to open, usually by means of the foot, so that the hydraulic fluid is permitted to flow from the space under the piston into the reservoir.

In case of an increase of the load – e.g. when a person is sitting down on the bed of the patient – (while the pump is stationary) the check valve will prevent from being lowered and hydraulic fluid being expelled towards the accumulator.

A disadvantage of the well-known unit is to be seen in that in case of a decrease of the load (e.g. when a patient is being lifted from the bed), the accumulator will – as a result of the pressure in the system being decreased – will supply hydraulic fluid to the cylinder and thereby cause an undesired raising of the bed. A further disadvantage is to be seen in that actuation of the reliet valve (with the purpose to lower the bed) will cause the accumulator to completely discharge, so that it has to be refilled in the process of the next raising procedure.

It is an object of the present invention to solve the problems referred to hereinabove.

According to the invention this aim is achieved in that a multiple pilot operated check valve of the differential type is provided in the branch conduit towards the accumulator, the largest and smallest end faces of the differential spool member being subject to the pressure in the branch conduit, while the differential area of th spool member is subject to the pressure in a conduit, which is branched off from the return conduit at a location between the orifice and the relief valv , in such a way, that the pressure in the branch conduit to th accumulat r t nds to cause the spool member and thereby the check valve to open, whereas the pressure in the second branch conduit tends to move the spool member into the closed position.

The invention will be hereinafter further described by way of example with reference to the accompanying drawings.

Fig. 1 is a diagrammatic side view of a hospital bed, having the actuating unit according to the invention incorporated therein and

Fig. 2 shows the hydraulic circuit diagram of the actuating unit according to the invention.

The hospital bed shown in Fig. 1 comprises a wheeled undercarriage 1, on which the patient supporting section 2 is vertically adjustably supported by means of a linkage system 3. For lifting and lowering of the patient supporting section 2 a hydraulic actuating unit 4 is provided, which is pivotally connected to the undercarriage 1 at 5 and which has its free piston rod end connected to a lever 8 at 7, said lever being rigidly coupled with the right-hand lever arms of the linkage system 3. In the drawing the patient supporting section 2 is shown in its raised position in full lines, which position corresponds with the extended position of the plunger of the actuating unit. The lowered position represented by broken lines corresponds with the retracted position of the plunger of the actuating unit.

The actuating unit 5 will be hereinafter further described with reference to the diagram of Fig. 2.

In said hydraulic diagram the piston-cylinder device 10 is connected to the pressure side of a hydraulic plunger pump 12 through a supply conduit 11, the suction side of the pump being connected to a reservoir 13 containing hydraulic fluid. A branch conduit 14 leads from the supply conduit 11 towards a hydraulic fluid accumulator 15. between the piston-cylinder device 10 and the branch off location towards the accumulator 15 a check valve 16 and a pressure dependent flow valve 17 are provided in the supply conduit 11. By means of the latter valve the cross-sectional area of the supply conduit 11 will – as a response to an increase of pressure – be restricted to an extent that the ratio between the amounts of hydraulic fluid, which are supplied at each pressure stroke of the pump towards the cylinder and the accumulator respectively, will remain merely constant. As a consequence of this the extent of shock absorbing will be independent of the load.

An orifice 19 and a normally closed relief valve 20, which may be opened by hand or foot, are provided in a return conduit 18 leading from the cylinder 10 to the reservoir 13.

A multiple pilot operated check valve 21 is provided in the branch conduit 14 towards the accumulator 15. This check valv is f th differential spool type. The larg st operational surface of th differential spool 22 (via pilot c ntrol conduit 14') as well as the smallest surface f said spool ar subject t the pressure in the branch conduit 14. The result of

the two forces acting upon the two spool surfaces tends to move the differ ntial spool 22 to the right and thereby cause the proper check valve 23 to open. A third pilot control conduit 24 is connected to the differential spool, however, which leads from the return conduit 18 at a location between said orifice 19 and said relief valve 20. This pilot control valve 24 acts upon the annular spool surface between said largest and said smallest spool surfaces. The pressure supplied through said pilot control conduit 24 produces a force which, in combination with the force acting upon said smallest spool surface, tends to move the spool 22 to the left and thereby cause the check valve 23 to close. An overload valve 25 is connected at a location between the valve 23 and the accumulator 15, which opens if the supply pressure exceeds a certain level and allows hydraulic fluid to return to the reservoir 13. Thus this valve provides adequate protection against unacceptable high accumulator pressures.

The piston-cylinder device 10, the reservoir 13 and the accumulator 15 are integrated into a compact unit, making use of a common base portion 27. The said base portion accommodates the various valves and conduits.

The actuating unit operates as follows:

In the starting situation the accumulator pressure (e.g. the gas pressure above the liquid in the accumulator) is assumed to be lower than the supply pressure required to displace the piston of the piston-cylinder device.

When, in this situation, the pump 12 is actuated, the early pressure strokes will cause the accumulator to be filled to an extent that the accumulator pressure has reached the level required to overcome the piston load. Each time during a suction stroke of the pump hydraulic fluid will flow from the reservoir 13 via the opened suction valve 12a into the pumping chamber, which fluid will, during the subsequent pressure stroke, flow to the accumulator via pressure valve 12b, branch conduit 14 and check valve 23.

As soon as the accumulator pressure has reached a level matching with the piston load, further actuating of the pump will cause hydraulic fluid to be supplied to the cylinder 10 via supply conduit 11, flow valve 17 and check valve 16. The supply pressure will simultaneously act on the largest (at the left) and the smallest (at the right) surface of the differential spool 22, as a result of which the spool 22 will be moved to the right and the check valve 23 will be mechanically pushed into its opened position. As a result of this there will be an open connection between the accumulator and the hydraulic cylinder, which open connection will be maintained for a short time upon each pressure stroke, during which time a certain amount of fluid is permitted to flow from the accumulator to the cylinder, thereby avoiding shocks.

In th meantime also th pressure in the pilot control conduit 24 will – with a certain delay – increase to a level corresponding to that in the supply and branch conduits 11, 14, so that the compl te spool will become subjected to th same (system) pressure, as a result of which the check valve 23 will close under the action of its return spring and th accumulator pressure, which situation will continue until – at a following pressure stroke – the pressure in the supply conduit 11 and the branch conduit 14 will temporarily increase to a level above the system pressure, as a result of which the spool 22 and the valve 23 will be temporarily kept open.

Assuming now a decrease of the piston load is taking place in a stationary position (i.e. in a situation in which the patient support section is taking the desired position), such decrease being e.g. the result of the patient being moved from the support section to an operating table, this will not result in any (undesired) movement of the support section because the valve 22, 23 will be kept closed so that no supply of liquid from the accumulator 15 can take place. Such additional supply of liquid from the accumulator will take place only if it is desired, viz. as soon as a next pressure stroke of the pump is being carried out. Initiating a next pressure stroke will cause the pressure in the supply and branch conduits 11, 14 to increase above the level of the decreased system pressure, so that the spool 22 will be no longer in balance and as a consequence of this will move to the right, so that fluid is permitted to flow from the accumulator 15 towards the cylinder 10.

By adjusting the level of the patient support section in the lowering direction – by actuation of the relief valve 20 – an immediate pressure drop will take place in the pilot control conduit 24, while the system pressure under the piston will slightly decrease. As a result of this the differential spool will be pushed to the right, thereby tending to cause the valve 23 to open, so that liquid from the accumulator 15 may flow to the cylinder 10. The situation, however, will be of a very short duration. For, after a slight delay the decreased system pressure will rule in the branch and pilot control conduits 14, 14', as well as in the pilot control conduit 24, which brings the differential spool 22 in balance again and causes the valve 23 and thereby the accumulator to close.

When the patient support section is lowered into its lowermost position (defined by a mechanical stop) will allow the system pressure to drop to zero, while the differential spool will remain in balance and the valve 23 will be kept closed.

Claims

1. Hydraulic actuating unit, in particular for raising a load, such as a hospital bed, comprising a reservoir (13) for hydraulic fluid and a hydraulic piston cylinder device (10), the cylinder of the latter having its ends connected to the reservoir (13) through a supply conduit (11) containing a hydraulic plunger pump (12) with suction and pressure valve means (12a, 12b) and through a return conduit (18) containing an rific (19) and a normally closed relieve valve (20) resp ctiv ly, a branch conduit (14) leading to a hydraulic liquid accumulator (15) being branched off from said supply conduit (11) at a location betwe n th cylinder (10) and the pressure

valve means (12b), a check valve (16) being provided in said supply conduit at a location between the branch conduit (14) and said cylinder (10), while a pressure dependent orifice (17) is provided between said check valve (16) and said branch conduit (14), characterized in that a multiple pilot operated check valve (21, 22, 23) of the differential type is provided in the branch conduit (14) towards the accumulator (15), the largest and smallest end faces of the differential spool member (22) being subject to the pressure in the branch conduit (14), while the differential area of the spool member (22) is subject to the pressure in a conduit (24), which is branched off from the return conduit (18) at a location between the orifice (19) and the relief valve (20), in such a way, that the pressure in the branch conduit (14) to the accumulator (15) tends to cause the spool member (22) and thereby the check valve (23) to open, whereas the pressure in the second branch conduit (24) tends to move the spool member (22) into the closed position.

2. Actuating unit according to claim 1, characterized in that the hydraulic piston cylinder device (10), the reservoir (13) and the accumulator (15) are built together into a compact unit, making use of a common base portion (27), in which the various valves and conduits are provided.

Patentansprüche

1. Hydraulische Bedienungseinheit, insbesondere zum Heben einer Last, zum Beispiel eines Krankenhausbettes, welche Einheit einen Behälter (13) für hydraulische Flüssigkeit umfasst, eine hydraulische Kolben-Zylindervorrichtung (10) deren Zylinder einerseits mittels einer, eine hydraulische Plungerpumpe (12) mit Saug- und Druckventil (12a, 12b) enthaltenden Zuführungsleitung (11) und andererseits mittels einer, eine Querschnittsverengung (19) und ein normal geschlossenes Entlastungsventil (20) enthaltenden Rückflussleitung (18), an den Behälter (13) angeschlossen ist, wobei von der Zuführungsleitung (11), an einer Stelle zwischen dem Zylinder (10) und dem Druckventil (12b), eine Zweigleitung (14) zu einem hydraulischen Flüssigkeitsakkumulator (15) führt, und in der Zuführungsleitung, zwischen der Zweigleitung (14) und dem Zylinder (10), ein Rückschlagventil (16) vorgesehen ist, während zwischen dem Rückschlagventil (16) und der Zweigleitung (14) ein druckabhängiges Strömungsregelventil (17) vorgesehen ist, dadurch gekennzeichnet, dass in der Zweigleitung (14) zum Akkumulator (15) ein mehrfach vorgesteuertes Rückschlagventil (21, 22) vom Differentialtyp vorgesehen ist, von welchem Ventil die grösste und die kleinste Oberflächen des Differentialschiebers (22) vom Druck in der Zweigleitung (14) beaufschlagt werden, während die ringförmige Oberfläche des Schiebers (22) vom Druck in einer, von der Rückflussleitung (18), zwischen der Querschnittsverengung (19) und dem Entlastungsventil (20), abgezweigten Steuerleitung (24) beaufschlagt wird, in der Weise, dass der Druck in der Zweigleitung (14) zum Akummulator (15) den Schieber (22) und dadurch das Rückschlagventil (23) zu öffnen versucht, während der Druck in der zweiten Zweigleitung (24) bestrebt ist, den Schieber (22) in die Schliesslage zu bringen.

2. Bedienungseinheit nach Anspruch 1, dadurch gekennzeichnet dass die Zylindereinheit (10), der Behälter (13) und der Akkumulator (15) zu einer kompakten Einheit zusammengebaut sind, unter Anwendung eines gemeinsamen Basisteils (27), in welchem die Ventile und Leitungen vorgesehen sind.

Revendications

1. Unité d'actionnement hydraulique, en particulier pour élever une charge, telle qu'un lit d'hôpital, comprenant un réservoir (13) pour un fluide hydraulique et un dispositif à cylindre et piston hydraulique (10), le cylindre de ce dernier ayant ses extrémités connectées au réservoir (13) par un conduit d'alimentation (11) contenant une pompe à plongeur hydraulique (12) avec des moyens formant vannes d'aspiration et de pression (12a, 12b) et par un conduit de retour (18) contenant un orifice (19) et un détendeur (20) normalement fermé, respectivement, une ramification (14) menant à un accumulateur de liquide hydraulique (15) partant dudit conduit d'alimentation (11) en un emplacement entre le cylindre (10) et le moyen formant vanne de pression (12b), un clapet (16) étant prévu dans ledit conduit d'alimentation en un emplacement entre ladite ramification (14) et ledit cylindre (10), tandis qu'un orifice (17) dépendant de la pression est prévu entre ledit clapet (16) et ledit conduit en ramification (14), caractérisée en ce qu'un clapet multiple à commande pilote (21, 22, 23) du type différentiel est prévu dans la ramification (14) vers l'accumulateur (15), les plus grande et plus petite faces extrêmes dudit organe formant tambour différentiel (22) étant soumises à la pression dans la ramification (14) tandis que la différence de surface de l'organe formant tambour (22) est soumise à la pression dans un conduit (24), qui part du conduit de retour (18) en un emplacement entre l'orifice (19) et le détendeur (20) de manière que la pression dans la ramification (14) vers l'accumulateur (15) ait tendance à forcer l'organe formant tambour (22) et ainsi le clapet (23) à s'ouvrir pour qu'ainsi la pression dans la seconde ramification (24) ait tendance à déplacer l'organe formant tambour (22) à la position fermée.

2. Unité d'actionnement selon la revendication 1, caractérisée en ce que le dispositif à cylindre et piston hydraulique (10), le réservoir (13) et l'accumulateur (15) sont construits ensemble en une unité compacte, en utilisant une portion commune de base (27), où sont prévus les diverses vannes et les divers conduits.

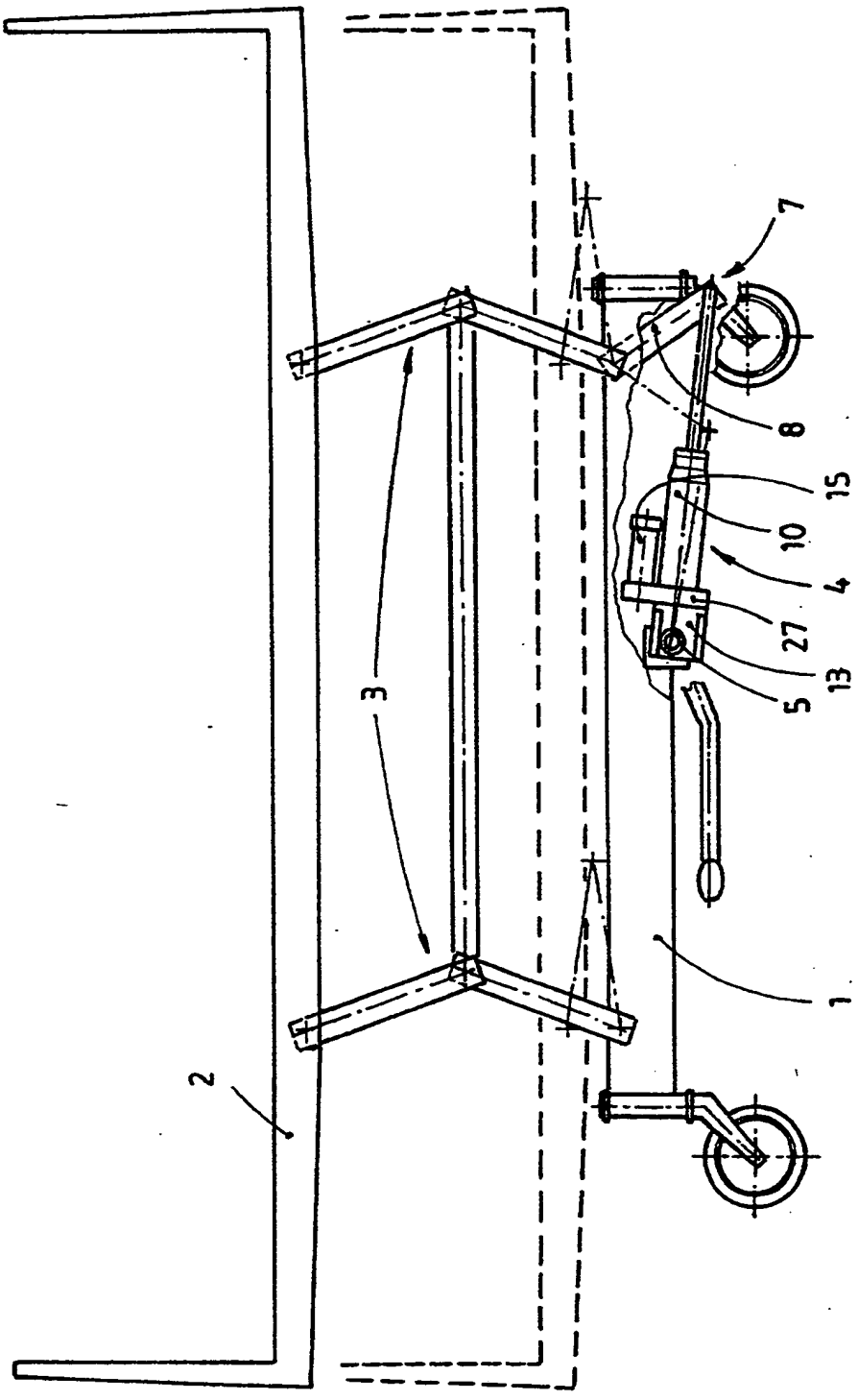

FIG. 1

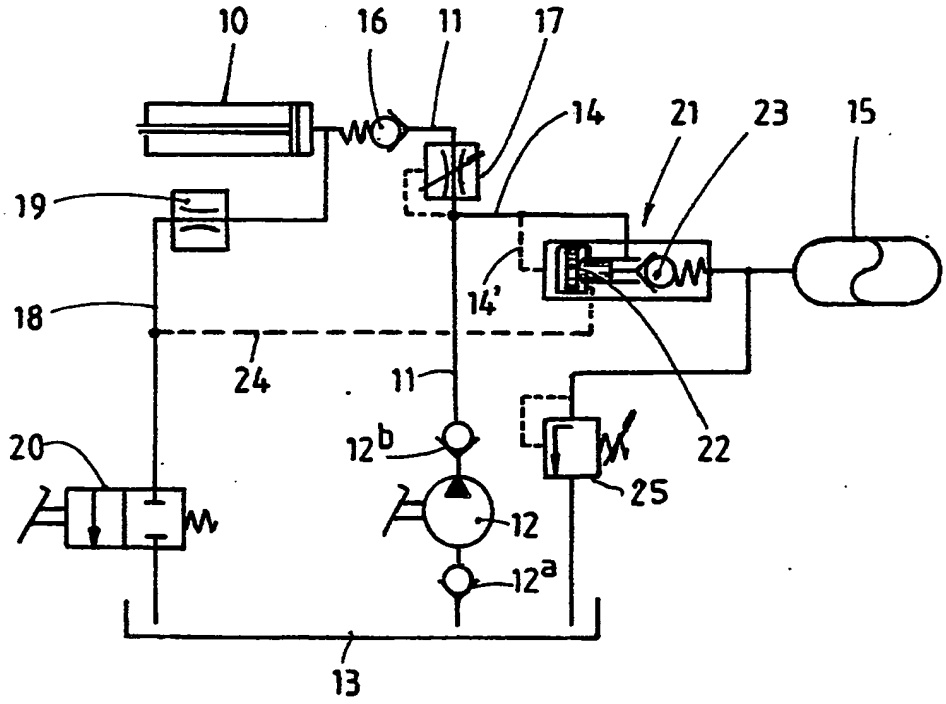

FIG. 2